Farm advisor Bob Miller evaluates oak woodland at a typical survey site in Tulare County.

South Sierra oak regeneration weak in sapling stage

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A recent survey of oak regeneration in four southern Sierra counties found sufficient regeneration of seedlings, but a general shortage of pole-size trees. Managers will need to find ways to encourage oak seedling recruitment into the pole-size class to ensure sustainable oak woodland stands.

A wide range of resource management professionals, landowners, and conservation groups throughout California have expressed concern about the long-term sustainability of oaks on rangelands. Several statewide surveys have documented poor oak regeneration in some areas of these oak-covered rangelands (also known as hardwood rangelands). Although these surveys have helped in developing a statewide policy on hardwood range management and prioritizing proposed research on oak regeneration, we cannot extrapolate their statewide results to local situations.

Hardwood rangelands provide a variety of important natural resources for private and public use. Historically, such areas have been managed to provide and maintain livestock production, wildlife habitat, water supply, outdoor recreational opportunities, and aesthetic resources.

The South Sierra Hardwood Range region consists of Madera, Fresno, Tulare, and Kern Counties, and includes almost 1.5 million acres of hardwood rangelands. Most of these areas are owned by ranchers, who have been responsible for ensuring the maintenance of oaks and the values associated with these trees. To date, available background information has not been sufficient to allow assessment of the current condition of oak regeneration on the hardwood rangelands in this important four-county area.

Our study is an attempt to provide baseline information on the status of the hardwood resource on rangelands in the South Sierra Hardwood Range region. In particular, we are emphasizing (1) the current distribution of regeneration in the region and (2) the factors contributing to the presence or absence of oak regeneration on a given site. This information can help us develop an initial assessment of the hardwood range resource's long-term sustainability, along with general management recommendations to ensure the maintenance of critical hardwood range habitat.

Description of the resource

Five species account for most of the oaks found on the hardwood rangelands in the South Sierra region. The black oak (*Quercus kelloggii*) occurs from the high-elevation mixed conifer sites down to lower, moister sites. The valley oak (*Q. lobata*) is found in riparian areas, in deep alluvial plains, and on moist hillside sites. The interior live oak (*Q. wislizenii*) and the canyon live oak (*Q. crysolepis*) grow in dense clusters on moist sites. Finally, the blue oak (*Q. douglasii*) occurs in mixed woodland stands with the other four species, and at the lowest elevations, just before moisture limitations cause the hardwood range to give way to open grasslands. Other prominent tree species in the hardwood range include foothill pine (*Pinus sabiniana*) and California buckeye (*Aesculus californica*).

Methods

We established regeneration transects in each of the four counties, beginning at low-elevation, open blue oak savannahs. The oak-covered hardwood rangelands began at an elevation of about 600 feet in the northern-most transects of Madera County, and at about 1,600 feet in the southern-most transects of Kern County. Annual rainfall at these low elevations averages 10 to 15 inches. Our elevational transects through the hardwood range sites headed uphill, generally west-to-east, until they reached the transition between hardwood range and mixed conifer forest at elevations of 3,000 feet (Madera County) to 4,800 feet (Kern County).

Fourteen to twenty regeneration survey plots were located at random in patterns radiating out from each of the four elevational transects. We checked the random plot locations to ensure that they occurred in the blue oak and mixed oak woodland vegetation types. If a plot did not match these hardwood types, we randomly selected an-other location. Plots were located exactly 200 feet to the north or south of the main elevational transects. Altogether, 68 plots were sampled for this study.

At each sample location, we laid out a strip transect 100 feet long and 12 feet wide (0.028 acres). Data were collected in 1987 and 1988. We took the diameter at breast height (DBH) and total height for each overstory tree (DBH greater than 1 inch) in the plot to assess the basal area, trees per acre, and volume per acre of the tree overstory. Slope, aspect, elevation, brush, and forage vegetation were recorded for each site, as well as grazing and tree harvesting history. We recorded species, height, and root collar diameter for all regeneration trees (less than 1 inch DBH).

Results

The effect of elevation on oak regeneration varied in the region, mainly because rainfall for a given elevation decreased from the northern to the southern sites. To correct for this, we based common "rainfall zones" on the elevation at which blue oaks first occur in each county. The data in table 1 show the four zones for each county and the average annual rainfall for each zone. In table 2, the average numbers of blue oaks and all oaks are given by height class for the four rainfall zones. Figure 1 shows the species composition of the oak regeneration (seedlings and saplings less than 10 feet tall).

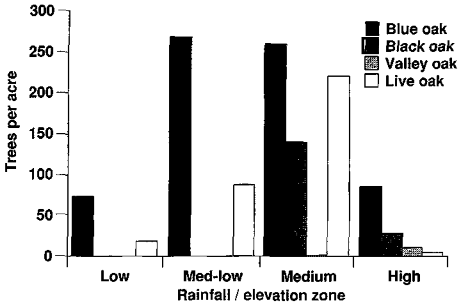

Fig. 1. Average per-acre oak tree regeneration rates for four oak species on 68 study sites over four rainfall zones of the South Sierra Nevada Region.

A general pattern emerged for oaks at all rainfall zones except the low zone: there are more seedlings (less than 1 foot tall) than mature trees (over 10 feet tall). At the lowest zone, there are in total fewer seedlings than mature trees. All rainfall zones have relatively fewer trees in the sapling (1 to 5 feet tall) and pole (5 to 10 feet tall) classes. This is most pronounced at the lower-rainfall zones.

The blue oak is the predominant species in the low rainfall zone (fig. 1). As the elevation and rainfall increase, more oak species are present.

Of the 68 plots in the survey, only 9 had no oak regeneration less than 10 feet tall. Seven of the plots without oak regeneration were found in the low rainfall zone, and made up 54% of all the plots in that zone. The other two plots without oak regeneration were in the medium-low rainfall zone, and represented 29% of all the plots in that zone. Every other sample plot (87% of the total) had at least one tree per plot shorter than 10 feet.

The data in table 3 show the result of the one-factor analysis of variance of average oak regeneration for five different site factors. The ungrazed areas had significantly more blue oak seedlings than grazed areas; however, the long-term effect of grazing was less pronounced, as the number of blue oak saplings was virtually the same regardless of whether an area was grazed. When all oak species are taken into account, grazing has no significant impact.

Although not statistically significant, there was a trend of more seedlings under moderate overstory tree densities (50 to 100 square feet of basal area per acre) than under stands that were more open (less than 50 square feet) or more dense (more than 100 square feet of basal area per acre). The number of saplings tended to increase as overstory density increased.

We used the number of woody tree and brush species on the plot as a proxy for the site's potential for oak regeneration. Sites with two or more woody species had significantly more oak seedlings than sites with only one woody species.

There were significantly more oak saplings per acre as elevation and rainfall increased. There tended to be fewer seedlings at the low rainfall zone, and about the same number of seedlings per acre at the medium-low, medium, and high zones. We found no general trends based on north versus south aspects.

TABLE 1. Rainfall zones for the four South Sierra Nevada counties

Rainfall zone	Rainfall	Elevation of rainfall zone within each county: Madera	Fresno	Tulare	Kern
	inches	*feet*			
Low	10–15	500–1,000	500–1,000	1,100–1,600	1,500–2,000
Medium-low	15–17	1,000–2,000	1,000–2,000	1,600–2,600	2,000–3,000
Medium	17–22	2,000–3,000	2,000–3,000	2,600–3,600	3,000–4,000
High	22–26	3,000–4,000	3,000–4,000	3,600–4,600	4,000–5,000

TABLE 2. Number of oak trees per acre, sorted by height class for different rainfall zones in four South Sierra Nevada counties

Rainfall	Blue oak height class				All oaks height class			
zone	<1 ft	1 to 5 ft	5 to 10 ft	>10 ft	<1 ft	1 to 5 ft	5 to 10 ft	>10 ft
Low	61.43	2.79	8.38	47.47	67.02	5.58	17.45	117.28
Low-medium	254.10	7.64	7.64	42.03	305.68	22.93	26.75	99.35
Medium	237.97	18.15	6.05	68.57	568.70	28.23	28.23	106.88
High	116.97	86.72	30.25	86.72	441.65	147.22	64.53	133.10

TABLE 3. Average number of oak seedlings (shorter than 1 foot) and saplings (between 1 and 5 feet) per acre for several site factors

Site factor		Blue oak Seedlings	Blue oak Saplings	All oak species Seedlings	All oak species Saplings
Grazing:	ungrazed	196.07	34.03	509.97	53.12
	grazed	62.70	39.60	439.63	60.50
	significance	S.	N.S.	N.S.	N.S.
Overstory basal area per acre:	0–50 sq. ft.	140.46	18.94	289.19	54.45
	50–100 sq. ft.	330.73	45.28	694.89	44.94
	100+ sq. ft.	128.45	29.81	559.45	71.60
	significance	N.S.	N.S.	N.S.	N.S.
Number of woody species:	1 species	80.16	33.28	86.56	30.72
	≥2 species	297.66	38.72	726.86	71.74
	significance	S.	N.S.	S.	N.S.
Aspect:	north	156.54	45.38	500.23	58.43
	south	165.65	23.10	454.22	52.43
	significance	N.S.	N.S.	N.S.	N.S.
Rainfall zone: (*see table 1*):	low	25.41	0.00	69.81	5.59
	medium-low	279.06	9.08	611.47	32.48
	medium	251.83	15.88	677.60	32.27
	high	175.45	130.08	447.70	141.17
	significance	N.S.	S.	N.S.	S.

* N.S. = no significant differences at the .05 level; S. = means are significantly different at the .05 level.

Discussion

The per-acre numbers of trees for the different height classes gives some insight into whether this area has a regeneration problem. The regeneration process involves the successful establishment of acorns in the landscape, their survival, and their eventual development into replacements for mature trees that die. One might speculate that there should be successively more trees at successively smaller size classes to account for natural mortality as the trees grow. However, patterns of uniform regeneration and mortality seldom occur on a single plot. On hardwood rangelands, climatic variations from year to year or unusual events (e.g., fire, spring rain, low wildlife or livestock numbers) may cause a large group of acorns to establish at one time under favorable conditions. Other "unusual" events may be required for this pulse of seedlings to be recruited into the sapling and tree size classes. A short-term analysis of the distribution of tree sizes would not show any long-term pulses as they graduate from one size class to the next.

Despite this study's short time-frame, however, the relatively small number of saplings in the 5-to-10-foot class suggests that there may not be enough new oaks coming along to replace mature trees as they die. Field studies have been initiated by UC researchers to look for the source of pressure keeping oak seedlings from developing into saplings, whether it comes from climatic forces, wildlife-related damage, livestock damage, or insect pests.

This study does show that there are fewer seedling and sapling oak than mature trees at the low rainfall zones of hardwood rangelands. These low elevations have the greatest moisture limitations, so landowners and resource managers need to be careful to maintain the health and vigor of the overstory trees. Recruitment of replacement trees may be very difficult to ensure, and may occur only in rare cases when acorn crop, grass competition, grazing pressure, soil moisture levels, and temperature are all favorable. Tree harvesting should be avoided in these low-elevation fringe areas where the first open stands of blue oak occur. At higher elevations, we found ample oak seedling regeneration to replace the mature trees in the stand. Still, we need to identify management practices landowners can use to ensure that seedlings can grow to the sapling and pole sizes, and eventually replace mature trees in the stand. Several studies now underway in different areas of California are evaluating a variety of management practices.

In future work, we will concentrate on developing models to evaluate the probability of adequate regeneration that will ensure the sustainability of oaks in hardwood rangeland areas. This will help landowners and policy makers concentrate their management activities such as firewood harvest or range improvement where regeneration is less of a problem, and help them design mitigation practices to enhance regeneration success in difficult areas.

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How quality relates to price in California fresh peaches

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During a single season, researchers compared California fresh peaches for quality and price at the producer and retail levels. While prices at both levels declined during the season, they responded differently to changes in quality characteristics. The results suggest a potential for increased revenues from marketing sweeter, more mature fruit.

If fruit producers and marketers are to satisfy their customers, they must first understand consumer perceptions of fruit quality. Consumers base their choices on some combination of observable characteristics including fruit size, color, shape, and amount of defects. These characteristics have intrinsic value but also indicate nonobservable qualities such as sweetness, juiciness, texture, and flavor. Because what constitutes fruit quality is a subjective decision, produce purchased in the retail marketplace reflects the preferences of not only the consumer, but the grower, shipper, and distributor as well.

Some experts believe that fresh fruit producers have been slow in responding to increased consumer preferences for higher quality. Growers may not be aware of price signals, which represent consumer preferences for quality, because of the limitations of production and marketing systems. This article will explore the possibility that the price transmission mechanism is imperfect and could result in production inefficiencies. Correcting these inefficiencies could affect production decisions related to quality.

Background

Hedonic price analysis is a method developed by economists to estimate the value of different product characteristics. Users of this method assume that all consumers measure the level of different characteristics in a commodity the same way, but place unique values on those characteristics. These values are the hedonic prices of those characteristics.

The hedonic price literature dates back to an application of these ideas by Frederick Waugh in 1928. Waugh estimated hedonic prices for various characteristics of vegetables on the Boston wholesale market. He collected data on prices and characteristics of asparagus, cucumbers, and tomatoes. The results of his analysis were a set of prices for characteristics. For example, Waugh found that by increasing the amount of greenness on the stalks of asparagus by one inch, the wholesale price increased by 34.45 cents per dozen bunches.

Data collection and analysis

This project involved the design, collection, and analysis of a large amount of data on quality characteristics of California fresh peaches. The quality characteristics measured were selected based on a review of relevant literature and consultation with industry and university researchers. Over 1,400 peaches were tested at the producer level and over 1,000 peaches were tested at the retail level. The data collection period spanned 14 weeks, between mid-May and the end of August. The quality characteristics measured were background color (using industry-supplied color chips), redness, weight (fruit size), and soluble solids measured by sugar content which produces a sweet flavor.

Because a fruit's variety is known at the producer level, both buyers and sellers are able to roughly assess the level of maturity of the fruit from its background color. The background color variable at this level is therefore adjusted for varietal differences. Although producers may directly test for the level of soluble solids, consumers must deduce soluble solids from visual and aromatic characteristics, by shopping at specific stores with good reputations, or by returning to those stores which have been most satisfactory in the past.

Using computer regression techniques, we simultaneously analyzed the effects of quality characteristics and seasonal timing on both the producer and retail markets. For